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NASA/DoD Aerospace Knowledge Diffusion Research Project

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Aerospace Knowledge Diffusion Research

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Contents

11 **FOREWORD**

13 **MANAGEMENT, RESEARCH AND SAFETY**

15 **The US National Aero-Space Plane programme**
Dr Robert R Barthelemy, manager
US National Aero-Space Plane Joint Programme Office

20 **The flight of the NASP X-30**
R W McGuffee, deputy director for the X-30 programme
General Dynamics Corporation

24 **Strategies for future profitability**
Ian Godden, director
OC&C Strategy Consultants

29 **Hopes and fears for 1993**
Robert Ebdon, head of commercial and government affairs
British Airways

31 **Aerospace knowledge diffusion research**
Thomas E Pinelli, co-director; John M Kennedy, co-director; Rebecca O Barclay, principal investigator; and Terry F Whiter, project director (Indiana University)
NASA

35 **Key elements of accident avoidance**
Earl F Weener, chief engineer
Bowing Commercial Airplane Group

39 **New developments in airfield lighting**
Anthony J Smith, research scientist
Royal Aerospace Establishment

45 **Computing technologies for real-time weather systems**
Ray Spiers, managing director
ACT Sigmax Limited

48 **Civil aerospace research in Australia**
Lincoln A Wood, principal researcher
Royal Melbourne Institute of Technology

51 **US aeronautical research for the 1990s**
Richard H Peterson, director, and Bruce J Holmes, deputy director
NASA

58 **High speed regional airliner for 1993**
Ulf Edlund, programme director
Saab-Scania AB, Saab Aircraft Division

60 **Future high speed rotorcraft**
Evan A Fradenburgh, director, research and advanced design
Sikorsky Aircraft

65 **AIRFRAME TECHNOLOGY AND SYSTEMS**

67 **It is neither leather, nor imitation leather, it is Lorica**
Dominique J Memoud, general manager
MFI Microfibres and Mario Camozzi, managing director
Lorica SpA

70 **Development of lightweight flightdeck windshields**
Robert Wright, marketing director
Triplex Aircraft & Special Products Limited

75 **Smart fly-by-light actuation**
Michael R Kinnings, R&D manager
Actuation Division, Lucas Aerospace

81 **Angle of attack/stall warning systems**
Rodney C Wainwright, executive and Jack C Rafferty, manager, military systems sales
Teledyne Avionics

83 **The A340 electrical power generation system**
Andy Barton, technical manager
Power Systems Division, Lucas Aerospace

87 **PROPELLION, DESIGN AND DEVELOPMENT**

89 **The GE90: combining the past with the future**
James W Tucker, general manager, GE90
GE Aircraft Engines

95 **The search for new materials**
Stewart Miller, managing director, Aerospace Group
Rolls-Royce

99 **Developments in engine test facility design**
George F Dawson, aviation director and joint managing director
Industrial Acoustics Company Limited

103 **FADEC widens its application base**
Michael Joby, manager, advanced controls
Lucas Aerospace

Aerospace knowledge diffusion research

Thomas E Pinelli, John M Kennedy, Rebecca O Barclay, and Terry F White
National Aeronautics and Space Administration

A co-operative research project is providing a pragmatic basis for understanding the aerospace knowledge-diffusion process from individual to international levels, which will help to increase productivity and improve the professional competence of aerospace engineers and scientists.

Aerospace research and development (R&D) is becoming more interdisciplinary in nature and more international in scope. Increasing co-operation and collaboration among nations is resulting in a more global manufacturing environment. These conditions are pressuring aerospace organisations to push forward with new technological developments and to maximise their involvement in R&D.

Recognition is growing within the aerospace community that knowledge transfer and diffusion is the key to the success of technological innovation. Although considerable research into technological innovation and knowledge diffusion has been conducted by various disciplines and from numerous perspectives, policy implications from the results of this research and investigation for aerospace are inconsistent, often contradictory, and frequently lacking.

Nevertheless, understanding the influences that motivate innovation and channel its direction is necessary to maximise aerospace R&D successfully. Meeting this challenge depends on a variety of factors, but largely on the efficient and effective transfer and diffusion of knowledge within the aerospace community. The problem is that, from an empirical standpoint, little is known about the transfer and diffusion of knowledge in the aerospace community.

Project overview

The project is a co-operative US effort between the National Aeronautics and Space Administration (NASA), the Department of Defense (DoD), and Indiana University. This research has been endorsed by the AGARD Technical Information Panel and the American Institute of Aeronautics and Astronautics (AIAA) Technical Information Committee.

The four-phase inquiry focuses on scientific and technical information (STI) as knowledge, the channels through which this knowledge is communicated, and the members of the social system associated with and involved in diffusing this knowledge throughout the aerospace community. The project is based on two premises: that although STI is essential to innovation, STI by itself does not ensure innovation; and that utilising existing STI or creating new STI, does often facilitate technological innovation.

STI is central to the innovation process and its management. Testimony to the central role of STI in the innovation process is found in numerous studies which show strong relationships between the communication of STI and technical performance at both the individual and group levels. These studies also show, among other things, that

United States aerospace engineers and scientists devote more time, on average, to the communication of STI than to any other scientific or technical activity.

Understanding how STI is communicated in the process of technological innovation is critical to developing and assessing the broad set of policies that influence the transfer and utilisation of aerospace STI. However, as important as the transfer and utilisation of STI is to technological innovation in aerospace, the linkages between the various sectors of the technology infrastructure are weak or poorly defined or both. Stimulating and nurturing aerospace technological innovation requires understanding of the context in which STI is transferred and utilised by aerospace engineers and scientists.

Information-seeking habits

Phase 1 of the project focuses on the information-seeking habits and practices of US aerospace engineers and scientists. The results of the Phase 1 pilot study indicate that US aerospace engineers and scientists spend approximately 65 per cent of a 40-hour week working with, or creating, new STI. Phase 1 will focus on the user of formal and informal channels to identify and obtain information, the use of STI products and services, and the reasons why these products and services are not utilised. Phase 1 activities will also investigate the extent to which selected demographic and attitudinal variables influence or explain information-seeking behaviour.

Knowledge transfer

Phase 2 concentrates on the transfer of knowledge and the model used within the US to distribute federally funded aerospace STI. This model is composed of an informal part that

		Phase 1 1989-1991	Phase 2 1990-1992	Phase 3 1990-1991	Phase 4 1991-1994
Level	National Individuals US Aerospace Engineers and Scientists	National Individuals and Organisations Aerospace librarians in government and industry US government and aerospace industries	National Individuals and Organisations US academic faculty, students, and engineering librarians	International Individuals and Organisations	
Focus	Knowledge production and use	Knowledge transfer and use	Knowledge transfer and use	Knowledge production, transfer and use	
Emphasis	Use, importance, and production of NASA DOD STI (technical reports) Impediments to access, transfer and use of NASA DOD STI	Use, importance, and production of NASA DOD STI (technical reports) Impediments to access, transfer and use of NASA DOD STI	Use, importance, and production of NASA DOD STI (technical reports) Impediments to access, transfer and use of NASA DOD STI	Use and importance of NASA DOD STI Impediments to access, and use of aerospace STI	
	Use and importance of AGARD and non-US STI Use and importance of information technology Information sources used in problem solving	Use and importance of AGARD and non-US STI Use and importance of information technology Effectiveness of system used to transfer US government funded STI	Use and importance of AGARD and non-US STI Use and importance of information technology Effectiveness of system used to transfer US government	Use of AGARD and non-US STI Use of information technology System used to transfer results of government funded aerospace STI, non-US aerospace STI, and systems, policies, and practices	
Subjects	AIAA membership SAE membership	US aerospace librarians in government and industry Selected US government facilities and aerospace companies	US aerospace faculty, academic engineering librarians, and US aerospace students (seniors) in USRA capstone design courses	RAeS, DGLR, and JSASS Aerospace faculties and students, and aerospace librarians	
Method	Self-administered mail questionnaires Pilot study Telephone follow-ups	Self-administered mail questionnaires Personal interviews Telephone follow-ups	Self-administered mail questionnaires Personal interviews Telephone follow-ups	Self-administered mail questionnaires Pilot study	
Desired Outcomes	Understanding of individual information-seeking behaviours of US aerospace engineers and scientists Explain use/non-use of US government funded STI products and services by US aerospace engineers and scientists	Understanding of the internal flow of aerospace STI in government and industry Understanding of the system used to transfer results of US government funded aerospace STI	Understanding of the internal flow of aerospace STI in academia Understanding of the system used to transfer results of US government funded aerospace STI	Understanding of individual information-seeking behaviour Understanding of the system used to transfer results of government funded aerospace STI Understanding of non-US aerospace STI systems, policies, and practices	

Figure 1. The NASA/DoD aerospace knowledge diffusion research project

relies on collegial contacts, and a formal part that relies on surrogates, information products, and information intermediaries to complete the producer to user transfer process. However, little is known about this model or about these systems in an empirical sense or about the role played by information intermediaries in the knowledge diffusion process.

The large-scale STI programmes operated by the DoD, Department of Energy (DoE), and NASA, emphasise accessibility through the use of various information products and services plus information intermediaries. These agencies maintain STI systems for acquiring, processing, announcing, and disseminating the results of government-performed and government-sponsored research.

Within these systems, the US government technical report is used as a primary means of transferring the results of federally funded R&D. Librarians and technical information specialists, as information intermediaries, serve as linking agents between producers and users, and between the formal and informal (collegial) components of the model.

The model used by the US government to disseminate the results of federally funded aerospace R&D is mainly a one-way transfer from producer to user. However, one-way distribution often results in an accumulation of unused and unwanted STI. Research shows that two-way, interactive (producer to user to producer) communication is needed for effective knowledge transfer. Regrettably, federally supported STI dissemination policies have not incorporated these research findings about effective information transfer. One researcher has characterised these federal STI systems as "passive, fragmented, and nonresponsive to the user context".

Academic sector

Phase 3 examines knowledge transfer and diffusion within the academic portion of the aerospace community. Successful technological innovation in aerospace is directly related to the size and competency of the pool of aerospace engineers and scientists. Faced with decreasing budgets and enrolments, university aerospace programmes must find ways to maintain and educate the next generation of aerospace engineers and scientists who will advance aerospace technology. The success of this undertaking will depend in large part on the transfer and diffusion of knowledge. Phase 3 explores the information seeking be-

haviours of aerospace faculty and students in an attempt to understand how knowledge transfer and diffusion operates within the academic community.

Non-US organisations

Phase 4 investigates knowledge transfer and diffusion among non-US aerospace engineers and scientists and aerospace organisations, specifically in Western Europe and Japan. As US collaboration with foreign aerospace technology producers increases, a more international manufacturing environment will arise, fostering an increased flow of US trade.

At the same time, however, international industrial alliances will result in a more rapid diffusion of technology, prompting the aerospace industry to forge ahead with new technological developments. To co-operate in joint ventures as well as to compete successfully at the international level, aerospace industries will need to develop methods to collect, translate, analyse, and disseminate the best of foreign aerospace STI. Therefore, an understanding of the process by which non-US aerospace engineers and scientists communicate at the individual and organisational levels becomes essential to successful technological innovation.

Present status

The initial thrust of Phase 1 is largely exploratory and descriptive, and examines aerospace knowledge use and production. Data was collected through the use of self-administered mail questionnaires. Phase 1 examined the behaviour of US aerospace engineers and scientists with respect to their use of the formal and informal systems when producing and using aerospace STI, and the importance of information technology and information products and services.

Members of the AIAA provided data about knowledge use, and members of the Society of Automotive Engineers (SAE) provided data about knowledge production. Collectively, the members of these two societies represent the entire spectrum of the aerospace R&D process in the US. Data collection and analysis for Phase 1 will be complete by the beginning of 1992.

Phase 2 focuses on aerospace knowledge transfer and use within the larger social system, placing particular emphasis on the flow of aerospace STI in government and industry, and the role in the knowledge transfer of the information intermediary (that is, the aerospace librarian or technical information specialist). Phase 2 examined many of the same concerns contained

in Phase 1 but from the standpoint of the information intermediary. Although the information intermediary is considered a vital link in the knowledge transfer process, a strong methodological base for assessing the intermediary's effectiveness is lacking.

A self-administered mail survey was sent to approximately 300 government and industry aerospace libraries in the US. Data collection and analyses were completed early in 1991.

Phase 3 focuses on knowledge use and transfer at the individual and organisational levels in the academic sector of the aerospace community. Phase 3 examined many of the same concerns contained in Phase 1 from the standpoint of the academic community. Self-administered mail questionnaires were sent to the faculty, undergraduate students, and libraries at all accredited aerospace programmes in the US. Data collection and analyses were completed in early 1991.

Comparative study

Phase 4 examines knowledge production, use, and transfer among non-US aerospace society members and aerospace organisations in the United Kingdom (UK), Germany, and Japan. Phase 4 is a comparative study that examines many of the same concerns contained in Phases 1, 2 and 3 at the international level. Self-administered mail questionnaires are being used to collect data from members of the Royal Aeronautical Society (RAeS) and the Aerospace and Defence Librarians Group, plus the faculty, students and academic librarians at those universities offering aerospace education in the UK. Similarly, data will be collected from members of the Deutsche Gesellschaft fuer Luft- und Raumfahrt (DGLR), information intermediaries in government and industry, and faculty, students, and academic librarians at German universities offering aerospace education. A similar plan has been proposed to the Japan Society of Aeronautical and Space Sciences (JSASS).

Timetable

Phase 4 is the longest segment of this multi-year project that began in 1988. Data collection in the UK began in spring 1991; collection and preliminary analyses should be complete by end of 1991. Data collection and analyses for the rest of Phase 4 will carry through to 1994.

An understanding of the process by which knowledge is diffused is necessary to successfully manage technological innovation in aerospace. In terms of

empirically derived data, however, little is known about the diffusion of knowledge in aerospace both in terms of the communications channels and the individual habits and practices of members of the social system. The NASA/DoD Aerospace Knowledge Diffusion Research Project seeks to enhance understanding of this process and thereby contribute to increasing productivity, stimulating innovation, and improving and maintaining the professional competence of aerospace engineers and scientists.

Project results will be documented in a series of project technical reports and

papers. In addition, papers will be presented at national and international conferences. □

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